TAMK UNIVERSITY OF APPLIED SCIENCE
BACHELOR'S THESIS
Environmental Engineering
Reza Mziray

COMPARATIVE STUDY OF HOSPITAL WASTE MANAGEMENT AND SEPARATION AT SITE

CASE STUDY OF TAMPERE UNIVERSITY HOSPITAL IN TAMPERE, FINLAND AND MUHIMBILI NATIONAL HOSPITAL IN DAR-ES-SALAM, TANZANIA

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ABSTRACT

Health-care waste regulations and policies are not well implemented in many hospitals especially in developing countries, this results is also presented by the World Health Organisation (WHO). Many hospital workers lack information regarding the generation, separation and disposal of medical waste. It hinders the well planning for better management system of health-care waste.

The key factor is the responsibilities of proper handling and disposal system of the waste. Absence of good waste management in many hospitals contributes to additional of public health-risks, poor separation and waste disposal. This problem leads to hazardous working conditions for hospital workers and patients.

In this thesis suggestion to better ways of handling and disposing health-care waste is the main target, to Muhimbili National Hospital.

Waste regulations and policies aims at proper health-care waste handling, minimization of health-care waste and prevention of risks caused by health-care waste. Many hospitals have their own waste instruction guide which makes it easier for the hospital workers to handle the waste generated.

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The case study was conducted so as to know the different system of health-care waste management in different countries how they differ especially in developed and in developing countries. Case study was Muhimbili National Hospital and Tampere University Hospital.

This was done by doing comparison of waste separation, waste generated and waste instruction guide from Tampere University Hospital and Muhimbili National Hospital. The study was carried out from October 2008 to March 2009; part of the study was through my practical training at Muhimbili National Hospital.
Main source of information were waste instruction guide for Muhimbili National Hospital, Helsinki University hospital and Tampere University Hospital. Also some oral interviews I had with several workers of technical department of Muhimbili National Hospital. The core problem and challenges of health-care waste starts at the separation point. This is due to poor knowledge of health-care waste utilisation, lack of awareness of health hazards. Hospital workers should be trained regularly, there should be aware of the existing health-care waste regulations and policies, to give them more skills and knowledge on the problems, to solve the existing problem.

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FOREWORD

The suggestion of writing my thesis topic came from the head of degree programme, of environmental engineering Marjukka Dyer. The suggestion came as the discussion of practical training, which I did for Muhimbili National Hospital for the period of three month.

Comparison of waste management system in separation of waste, classification, colour coding, transportation and waste instruction guide between Muhimbili National Hospital and Tampere University hospital came into our knowledge. The idea of comparison between the two hospitals was to bring out better suggestions on methods and procedures of handling health-care waste.
The plan of the thesis began on October 2008 with the help from my supervisor Seija Haapamäki. We had begun with familiarising waste instruction guide of Helsinki University Hospital; it helped us out on the standards which already exist in handling of health-care waste.

First of all I would like thank my supervisor Seija Haapamäki for her cooperation and working hand in hand with me, giving me the courage and support throughout the whole time of writing. I would like to thank my Husband Chrispin Nicholas Kinabo for giving me the support and motivation in writing and searching for the materials, I would like to thank him for being at Muhimbili National Hospital at the time of my training.
I appreciate the support and ideas from the head of degree programme Marjukka Dyer and I am thankful for all my teachers at Tampere University of Applied Science for all their support throughout the whole study time and lastly I would like to give my gratitude to all workers of Muhimbili National Hospital, especially Director of Technical services Gaudence Aksante, Mr John Mrema and Professor Nicholas Kinabo for introducing me to members of Technical department of Muhimbili National Hospital.

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ACRONOYMS AND ABBREVIATIONS

MNH - Muhimbili National Hospital

IPC - Infection Prevention Control

TB - Tuberculosis

MOH - Ministry of Health

HCF - Health Care Facility

HCW - Health Care Waste

MUCHS - Muhimbili University college of Health Sciences

MUHAS - Muhimbili University of Health and Allied Science

HUMAN IMMUNODEFICIENY VIRUS - Human Immunodeficiency Virus

TAUH - Tampere University Hospital

HUS -Helsinki University Hospital

TAMK - Tampere University of Applied science

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PVC'S -Polyvinyl Chlorides

STUK-Säteilyturvakeskus, Radiation and Nuclear Safety Authority

WHO - World Health Organization

EPA – Environmental Protection Agency

1. Introduction

The theme of this thesis was suggested by Head of Department Environmental Engineering of Tampere University of Applied since in October 2008, as the topic for my practical training topic.
The study begun with familiarising the waste instruction guide of Helsinki University Hospital and making a sketch plan for the field study in Muhimbili National Hospital.
I started my practical training at Muhimbili National Hospital in December 2008 to March 2009. The main task was observation of hospital waste management of National Muhimbili Hospital, the waste generation, separation and disposal. I carried out the study through oral interviews from the top level technical department of Muhimbili National Hospital to the normal workers; I had visited different wards, collection points and I had been taken to see how the hospital incinerator functions.

We made an excursion to Tampere University hospital in April 2009; and we were taken to one of the ward and shown how they separate their hospital waste. We had an opportunity to also see the collection point of Tampere University Hospital, different methods used for their waste collection at the hospital. We had an opportunity to see how the waste of Tampere University Hospital is handled, and collected.
Most of the information was gathered through the oral interviews with Muhimbili National Hospital workers, waste instruction guides from Muhimbili National Hospital, Tampere University Hospital and Helsinki University Hospital.

This case study was conducted to get more understanding and knowledge on the environmental management concerning hospital waste management, by doing comparison on waste separation and disposal system of Muhimbili National Hospital in Dar-es-salaam, Tanzania and Tampere university hospital in Finland

hospital waste instruction guide of 2008. Muhimbili National Hospital and Tampere University Hospital are both public referral hospitals, dealing with massive incoming and out-coming patients; therefore it is important that the health-care waste (hospital waste) is handled with great care.

1.1 Definitions of waste generated from Hospitals

Hospitals generate mainly solid municipal waste, hazardous waste which is considered as infectious waste and maybe toxic or radioactive. Approximately 80% of waste produced from hospitals is solid municipal waste, which is non-contaminated waste and poses no infectious risk to the personal who handles it. /3/

Healthcare waste includes all the waste hazardous or not generated during medical activities, there are by-products of healthcare, example sharps, non-sharps, blood, body parts, chemicals, pharmaceuticals, medical devices, and radioactive wastes, paper waste , food remainigs./17//13/

Infectious waste is defined as the waste which is capable of producing infectious diseases. For the waste to be infectious, it must contain pathogens with virulence and quantity so that the exposure to the waste by a susceptible host could result in an infectious disease./7/
The waste may have originated from the diagnostic as well as preventive curative and palliative treatments in the field of human and veterinary medicine. These waste if not properly managed can risk of infectious diseases to both workers, patients and the public in general. /17/ /3/

The management of health-care waste requires an increased attention and diligence to avoid the substantial disease burden associated with poor practice, including exposure to infectious agents and toxic substance. Incinerators provides an interim solution especially for developing countries where options for waste disposal such as autoclave, shredder, or microwave are limited /3//10/

1.2 General Overview of Health-Care waste

Health-care waste management it's all the activities from administrative level, operational systems which includes handling, insight and off-sight treatment, storage, transporting, and final disposal of waste. The absence of good health-care waste management maximises health risks to the public (patients, hospitals workers and community)./13//3/

From figure 1 below the 80% of solid municipal waste includes paper waste, textile waste, bio-waste, glass, cardboards, magnetic tapes, cans and 20% includes special medical waste, medicine waste, chemical waste and mercury waste. From the 20% of hazardous waste, infectious and anatomic waste makes up 15%, sharps waste represents 1%, 3% chemical and pharmaceutical waste, and 1% of genotoxic waste, radioactive matter and heavy metal. /16//17/

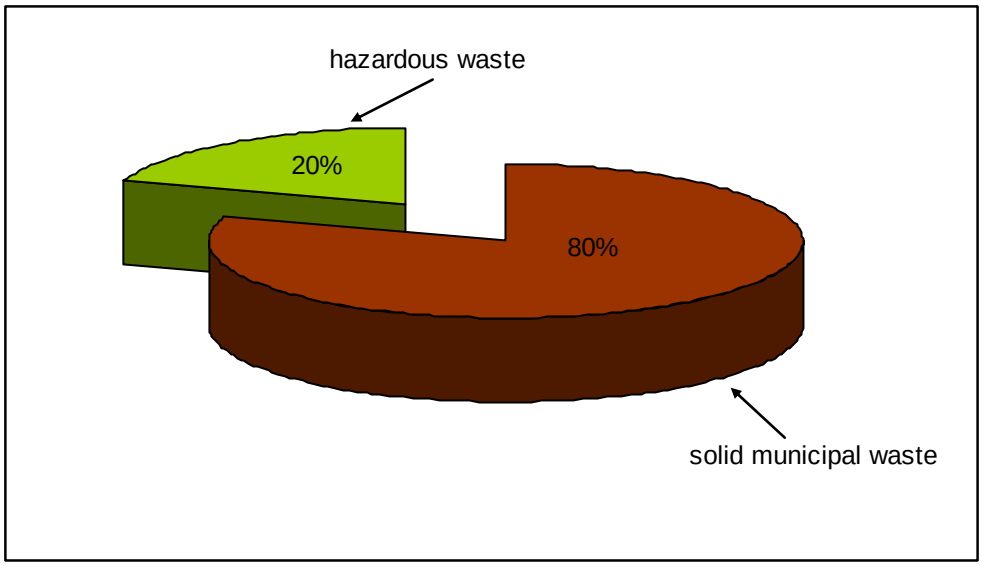


Figure 1. General health-care waste composition according to World Health Organization

Source: http://www.who.int/mediacentre/factsheets/fs253/en/

WHO states " Health-care waste is generated in wide variety of sources, starting from the hospital as a primary target, physician offices, laboratories waste, mortuary and autopsy centres, human and animal clinics.
High-income countries can generate up to 6kg of hazardous waste per person per year. In the majority of low-income countries, health care waste is usually separated into hazardous or non-hazardous waste. In these countries, the total health-care waste per person per year is 0.5 to 3kg'' /16/

1.3 Health- Care Impacts

Improper management of health-care waste causes serious health (diseases, injuries) and environmental problems in terms of water, air and land pollution. The health-care waste impacts pollutants maybe in the form biological pollutants, chemical and physical. Individual exposed to hazardous HCW are potentially at risk of being injured or infected
Treatment, proper handling and proper disposal of health-care waste aims to reduce the chances of imposing health risk to the society. Society can be infected either directly or indirectly through various routes. Disposal of HCW in open areas cause major effects to the population. /16//13/

Hazardous health-care waste has a potential of transmitting and harm hospital patients, hospital workers and the public as general. Other risks associated with health –care waste includes injuries and burns caused from sharps and radiation, infectious diseases from chemical waste and special medical waste, pollution caused by incineration of hazardous waste at low temperature./16/
Unmanaged health-care waste constitutes a hazard to personnel because it contains toxic chemicals and pathogens/16/

- Dumping of health-care waste can potentially result in contamination of water and soil especially when there is waste disposal near the water sources

- Incineration of unsuitable materials or when there no proper filtration can result in the release of pollutants into the air. The incineration of materials containing chlorine can generate dioxins and furans, which are classified as possible human carcinogens and have been associated with a range of adverse effects. Materials containing chlorine should not be incinerated

- Incineration of heavy metals or materials with high metal contents (in particular lead, mercury and cadmium) can lead to the spread of heavy metals in the environment

- Birds and animals usually carry the infected materials from hazardous waste, when the waste in not properly kept safely.

1.3.1 Infectious waste and sharps

Infectious waste contains a great variety of pathogenic micro-organisms. Pathogens in infectious waste may enter a human body through a number of routes:

- Puncture, abrasion, or cut in the skin
- Through mucus membrane
- By inhalation
- By ingestion

This pathogenic micro-organism can cause respiratory infections, genital infections, anthrax, meningitis and many more. /15/

The WHO figures and statistics states that “Throughout the world every year an estimation of 12,000 million injections are administered. All the needles and syringes are not properly disposed of. This is generating a considerable risk for injuries and infection and too many opportunities for re-use.
Worldwide, 8-6 million people hepatitis B, 2.3 to 4.7 million hepatitis C, and 80 000 to 160 000 Human Immunodeficiency Virus (HIV) infections are estimated to occur yearly from re-use of syringe needles without sterilization2’’./3/

I. The major problem in developing countries is waste disposal and waste sorting at the point of generation. Additional hazards occur from the scavengers at the waste disposal sites.

II. In many countries sorting of the waste is done manual. These practices are common in most regions of the world, These hospital workers are at immediate risk of the needle-stick injuries and other exposures to toxic or infectious materials./3//16/

III. There is danger of getting wounded by broken glass. Sharp edges can cause bleeding and danger of infection.

Many of these infections could be avoided if there is appropriate waste handling especially of needles and syringes. In many parts of African, Asia, central and eastern Europe the re-use of disposable syringes and needles is most common. /4/

1.3.2 Chemical and pharmaceutical waste

Many chemicals and pharmaceutical waste used in Health-care establishments are hazardous (toxic, geno-toxic, corrosive, flammable, reactive, explosive, and shock-sensitive). These substances are usually in small quantity in health-care waste; larger quantities maybe found when unwanted or outdated chemicals and pharmaceutical are disposed./3/ They may cause intoxication, either by acute or by chronic exposure, and injuries, including burns. Chemicals residues discharged into the sewerage system may cause adverse effects on the operation of the biological sewage system plants or toxic effects on the natural ecosystems of receiving waters./15/

1.3.3 Radioactive waste

Radioactive waste can cause headaches, dizziness, vomiting and destruction of genetic material. The type of diseases caused by radioactive waste is determined by the type and extent to exposure./7//3/

2. Background

2.1 Tanzanian legislation guiding waste management

Waste management in principle, is directly the responsibility of local authorities.

The local government (urban authority) Act 1982 (section 55 grams) imposes on urban authorities the mandate “to remove refuse and filth from any public or private place’’ and to provide and maintain public refuse containers for the temporary deposit and collection of waste./19/

Environmental management Act 2004, part IX of waste management states that, for the purpose of ensuring the minimization of the solid municipal waste in their respective geographical areas of jurisdiction, the local government authorities shall prescribe/18/:

- For different kinds of waste or refuse or garbage to be separated at the source ;

- For standards to guide the type, size, shape, colour and other specifications for refuse containers used; and

- For mechanisms to be put in place to involve the private sector and Non-Governmental Organizations on planning, raising awareness among producers, vendors, transporters, manufacturers, and others on the need to have appropriate containers and enhance separation of waste at source

2.1.1 Local Authorities

Municipal is responsible for managing the general waste such as to ensure the availability of sufficient services for refuse collection and might sail removal from households. The government provides all the necessary guidance (legislation and policy), financial grants and other useful resources when available./19/

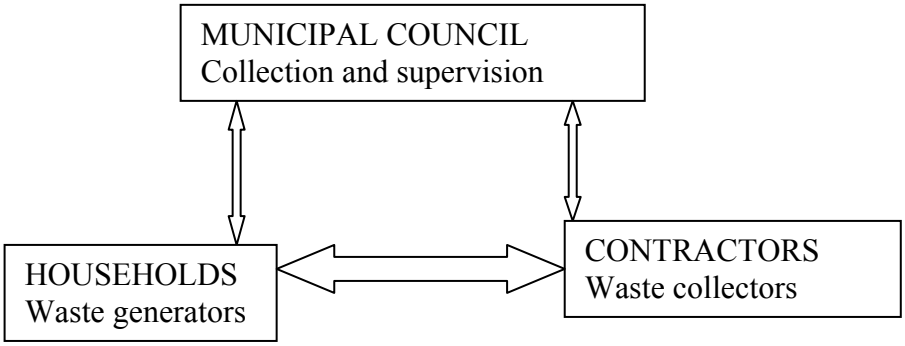


Diagram 1. Tanzanian relationship of local authority waste management

Source: http://jp1.estis.net/includes/file.asp?site=chip&file=12C88AF9-65B0-4C84-B3AD-

2.2 Finnish legislation guiding waste management in Finland

There are several EU-directives and Finnish laws that Finland uses for its waste management system. The national waste plan which was prepared in 1994-1995 is accordance with the principles of EU waste strategy./9/

In Finland the waste legislation includes:

- "The waste Act (1072/1993) and waste decree (1390/1993), which came to force in January 2004. They implemented the provisions of Council Directive (75/442/EEC) on waste, Council Directive (91/689/EEC) on hazardous waste, and Council Regulation No 259/93 on the supervision and control of transfrontier shipments of waste".
- "Guidelines of the Ministry"
- "Municipal Environmental regulation"

The EU objectives in the Finnish National waste plan are: /9/

- Prevention of waste generation and minimization of the harmful properties of waste
- Increased waste recovery
- Safe and sound waste disposal
- Prevention of environmental and human health risk arising from waste and repair of any damage
- Reduction on the transfrontier shipments of waste

2.2.1 Local authorities

On the local level municipalities supervise also the waste issues and give permits for minor waste actions like composting and collecting of waste. There are about 450 municipalities in Finland but smaller municipalities make cooperation with each other on these items./9/

3. Health-care waste management system in Tanzania

3.1 General information waste management in Tanzania

Efforts to manage health-care waste differs between countries, however the worse scenario being in developing countries like Tanzania. As it is reflected in WHO, in the IP report of the year 2000:

- Over 2 million people in Tanzania were HUMAN IMMUNODEFICIENY VIRUS-infected
- An estimated cumulative of 722, 490 people were suffering from AIDS
- There were 54,442 cases of tuberculosis and 1300 cases of Cholera
- 26,450 diarrhoea cases

The number of infectious diseases was increasing in Tanzania due to lack of environmental policy guidelines, inadequate knowledge and skills among health-care service providers.
The Ministry of Health in Tanzania (MOH) is firmly committed of ensuring safe, quality health care services to the people of its Nation and providing protection from outbreaks of infectious diseases. /3/

HCW generation in Tanzanian Hospitals is being measured taking into considerations the number of beds available in a given hospital, also waste generations per section. Large amount of waste is generated from the surgical department section.
MNH do not incinerate PVC's plastics, X-rays films, aerosols cans, organics and inorganic materials together./3//4/

3.2 General information of Muhimbili National hospital

MNH is located in Dar-es salaam city situated in Ilala district, which is at the centre of the region. Dar es Salaam is the main city of Tanzania with approximately 4 million inhabitants. MNH has 1,400 beds facilities; it is the main referral and teaching hospital of eastern zone and is the largest hospital in Tanzania.
Origins of MNH can be traced back in 1910 to 1920's known as the Sewahaji hospital. In 1956 the name changed to Princess Margareth hospital. Soon after independence in 1961 it was named Muhimbili hospital to 1976 when it was changed to Muhimbili medical centre. MNH was established the MNH ACT of parliament no.5 of 2000 by the separation of the Muhimbili Medical Centre (MMC) into MHN and MUCHS, and now to MUHAS. The separation was effected in November 2004. /11//19/

3.3 Organization structure of Muhimbili hospital

Muhimbili hospital is under the ownership of Tanzanian government. It has approximately of 2700 employees; of whom 300 are doctors and specialist, 900 registered and enrolled nurses, the rest are supporting operations employees./11/

Muhimbili National Hospital is organized into seven directorates, which are;

1) Clinical services
2) Nursing services and quality
3) Clinical support services
4) Human resources
5) Finance and planning
6) Technical services
7) Information and communication technology

Muhimbili hospital has 25 departments and 106 units.

The hospital main services are divided in two categories;

a) Health care services
b) Muhimbili University of Health and Allied Sciences (MUHAS)

3.4 Policy statement of Muhimbili National Hospital

- All waste generated in the course of various hospital activities shall be disposed of accordingly for public and general environmental health protection./3/

- Every contractor who is engaged in waste collection and disposal, is supposed to deposit all waste as directed in the contract between Muhimbili National Hospital and the contractor, as well as the contractor and the city council /3/

- The waste must be collected regularly and all process involved must comply with the MNH standard operating procedures for health-care waste management./3/

- All staff, patients and other stakeholders shall follow the rules and regulations for health-care waste management in all MNH premises./3

- The policy aimed at safeguarding Hospital's environment for the benefit of employees, patients and other stakeholders./3/

3.4.1 Instruction of waste handling in Muhimbili National

I. Protective instruction

- It is suggested to wear recommended protective gears during collection, transportation and disposal of waste and also to ensure continuous flow of liners, Personal Protective Gears and other necessary requirement for waste management from supplies department./4/

- Incinerator operators shall use mask which can absorb various micro-organism like TB bacterial./4/

- Following the National IPC guidelines, all waste handlers should report immediately to all sharps of injury/splash as far as PEP is concerned guidelines./4/

II. Waste instruction

- The hospital waste is not suppose to be stored transfer stations for more than two days and disinfect the waste storage room to prevent biological growth./4/

- Transportation of hazardous waste is done by using closed, leak proof truck marked with bio-hazard symbols

- Separate the colour coded receptacles with liners and lid for infectious, non-infectious waste and sharps waste

- Filled liners (bags) should be should be closed and removed when they are half full, as well as sharp boxes when filled to the mark indicated in the boxes and to be replaced with new ones/4/

III. Cleaning instruction

- There should be enough water supply for cleaning processes near incinerators as well as proper drainage system /4/

- Cleaning of the incinerator house should be done after every incineration cycle /4/

- The transfer stations should be decontaminated and cleaned using the disinfectant /4/

3.5 Waste generation Muhimbili National Hospital

Technical department in Muhimbili hospital is the department responsible of waste management control and procedures. Technical department falls under two units the waste management and landscaping.
MNH follows the municipal law which points out that "Infectious waste has to be burnt and the solid municipal waste (non-infectious) has to be taken to the municipal dumps''.
Infection Prevention Control (IPC) policies and guidelines is used in MNH for giving instructions and educating the staffs about waste handling.
The head of technical department is responsible of waste management system in the hospital, separation of waste production, and handling and to make sure that the waste is being taken to the right place./1//3/

MNH waste classification is based on Non- infectious waste (solid municipal waste), infectious waste and chemical waste.

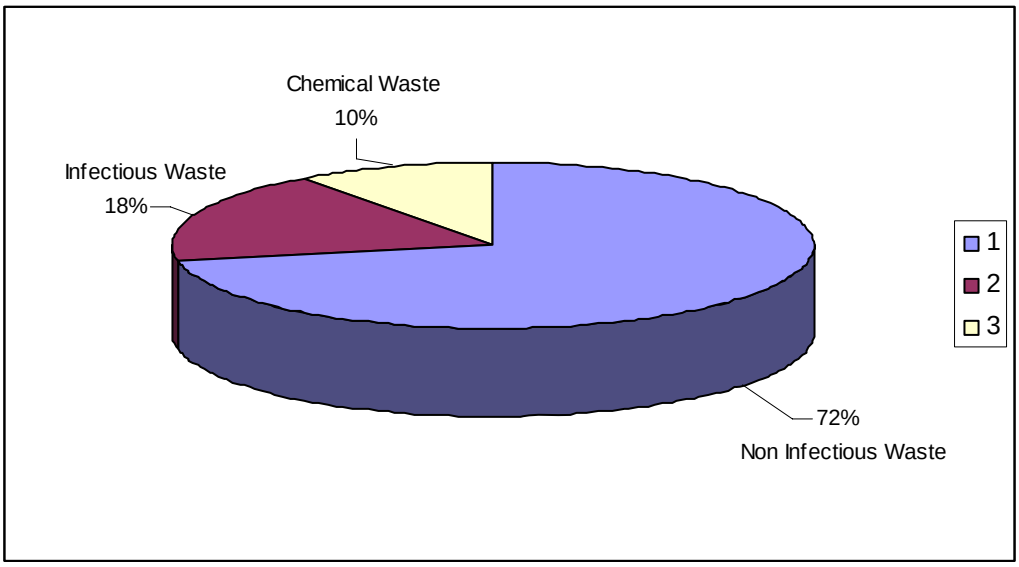
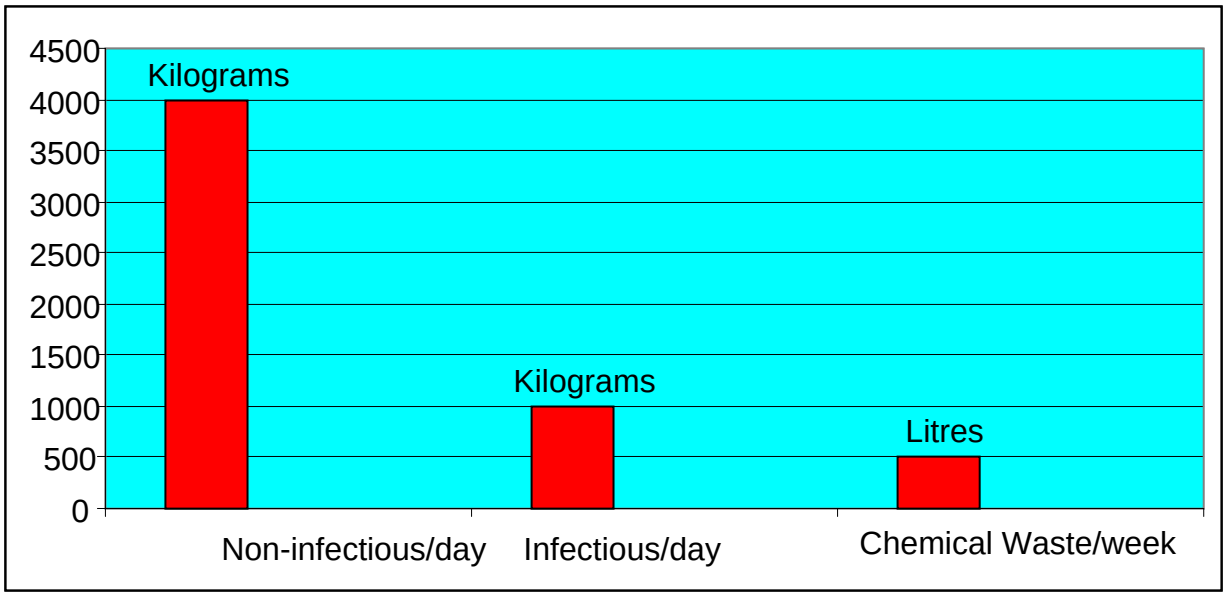


Diagram 2. Waste generated at Muhimbili National Hospital 2008

The hospital generates approximately 4000kg of Non-infectious waste per day, 1000kg of infectious waste per day and approximately 500litres of chemical waste.
The waste is being generated in the theatre, wards, and mortuary, offices and staff quarters./1/

From Non-infectious waste, mixed waste takes a large proportion of the waste volume, if such waste was not mixed up, it can be easily be handled. The chemical waste is collected and treated with the contractors who have the authorized chemical waste disposal certificate. The infectious waste is treated and incinerated with the hospital incinerator. The incineration has a capacity of incinerating 1200kg of infectious waste in 8hours. The infectious waste is incinerated four times in a week. /13/

3.5.1 Waste composition at Muhimbili National Hospital



Graph 1. Waste composition of Muhimbili National Hospital

3.5.2 Waste production at Muhimbili Hospital in a year

a) Non-infectious waste production in tones per year

4000kg of Non-infectious = 1 day

365 days ×4000kg =1,460,000kg/year

1kg = 0.001ton (metric)

$$1{,}460{,}000\text{kg/year} = \frac{1460000kg \times 0.001ton}{1kg}$$

= 1460tonnes per year of Non-infectious waste

b) Infectious waste production in tones per year

1000kg of infectious waste = 1 day

365days ×1000kg = 365,000kg/year

$$\text{Infectious waste in tones} = \frac{365000kg \times 0.001ton}{1kg}$$

$$= 356\text{tones per year of Infectious waste}$$

c) Chemical waste production in a year

500litres of chemical waste = 1 week

48weeks × 500liters = 24,000litres/year

MNH produces 1460tones of Non-infectious waste per year, 356 tones of Infectious per year and 24,000litres of chemical waste in a year.

3.6 Muhimbili National Hospital waste

Table 1 shows category of Muhimbili national hospital

Waste type	**Waste content**
Infectious waste	Human blood and blood product
	Pathological waste (tissues, organs, body parts, blood, and body fluids removed during surgery).
	Autopsy and biopsy
	Contaminated sharps
	Contaminated animal carcasses, body parts and bedding
Non- Infectious waste	Bio Waste
	Paper Waste
	Plastics
	Cardboard
	Textile waste

The daily processes at MNH, in the afternoon the infectious waste is being taken to the incinerator and at the night time they are being kept (shed) and treated with disinfectant until the next day. Non-infectious is taken by the municipal dumpsites./3/

Municipal gives permission to the department to rent the waste management cleaning company to empty the non-infectious waste. The technical department has contracts with different waste management cleaning companies/3/

3.6.1 Storage facility

In every ward the health-care waste generated is collected and stored in different plastic bags, bins or containers according to the waste type. The hospital workers follow the instruction guide available at the hospital for waste collection.
In all health-care facilities, a separate central storage is provided for hazardous health care waste (HCW), except radioactive waste that is stored specifically.
No waste is stored for more than two days before being treated or disposed.
The waste collection points of Muhimbili National hospital are within the hospital premises located few metres from each ward. Food canteen and quotas are away from the MNH collection points. The availability of water in the collection points is well provided for easy cleaning of the collection points./4/

In the Figure 2, collection point they keep infectious waste from the wards in which during the day when the required amount has exceeded , it is taken to the incinerator to be burnt. The infectious waste normally are burnt with incinerator of temperature of 800-900^0 c. /3/

Figure 2. Collection point of Muhimbili National Hospital in one of the wards

Figure 3. Infectious and Non-infectious waste mixed together

The red bag contains the infectious waste and green/blue non- infectious. Non – contaminated items for recycling is packed in a specific blue containers marked "Non-contaminated plastics, to be recycled''. The Non-contaminated waste is then collected, packed in separate boxes and delivered to or picked up by local Contractors capable of recycling them with environmental friendly techniques./3//4/

After the infectious waste is removed from the storage room, the responsible personnel usually clean the place using the water pipe which is usually inside this room in the above picture and squeeze the water out to the outlet on the side.

3.6.2 Waste separation and colour coding

The HCW are discarded at the point of use by the person who used the items. The waste is separated according to the colour coding of Muhimbili National Hospital.
The procedures of handling HCW, including segregation, packing of waste, and labelling is explained to all the workers and they have the instruction on board for each ward./4/

At separation the waste get mixed up, some of non-infectious waste ends up with infectious waste at the collection point. Therefore the some time there is a large amount of infectious waste which goes to the incineration point.
The staffs at the hospital usually use the trolleys to load the waste from the collection points and take all the infectious waste to the incinerator.
All the infectious waste is normally named and sealed with appropriate adhesive tape. /3/

The relevant local government authority approves the off-site transportation plan before any transit occurs in case of the off-site transportation for the treatment of hazardous HCW.

The transportation system of waste in MNH follows the instructions of the IPC guide which states “transportation is properly documented, and all vehicles carry a consignment note from the point of collection. Vehicles used for carriage of yellow bags are not allowed to be used for any other purposes’’. /3/

Table 2 shows the colour coding systems of HCW in Tanzania.

COLOUR	**TYPE OF WASTE**
YELLOW	**Safety box with sharps, needles and syringes:** Needles, blades, broken glass, lancets, scissors, broken ampoules, slides and slides covers, bin w papers, pharmaceuticals packaging, infusion bag plastic bottle, broken glasses
RED	**Wet infectious materials:** Blood, body tissues (amputations), body fluids (discharges), specimens (stool, sputum, placenta wet dressings, catheters, blood bags)
BLUE	**Non- infectious materials:** Bio waste, Papers, Plastics, Cardboards, Textile waste.

The colour coding systems aims at ensuring an immediate and non-equivocal identification of the hazards associated with the type of HCW that is handled and treated.

Figure 4. The truck collecting waste at the collection point at Muhimbili National Hospital

All sharps are kept in a specific cardboard or plastic safety boxes resistant to punctures and leakage, designed so that items can be dropped using one hand and no item can be removed. The safety box is coloured yellow and marked “danger contaminated sharps’’ /1//3/

Hazardous pharmaceutical waste and Cytotoxic are repacked in cardboard boxes marked, “Danger Hazardous Pharmaceutical and Catatonic Waste’’. It is returned to the medical stores department that shall ensure its disposal at central level./1/ /3/

In figure 5, all the sharps (syringes, needles, blades and broken glasses) causes’ potential risks when are not well handled and can increase infection diseases. Therefore all the sharps are collected in the yellow safety resistant boxes marked dangerous contaminated sharps. Sharp wastes are collected at the point of generation. Needles are usually removed and separated from the syringes./3/

Figure 5. Collection of sharps and infectious waste

Figure 6. Infectious waste collection point

Figure 7. A bag of infectious waste outside the collection point

4. Health-care waste management in Finland

4.1 General information waste management in Finland

In the hospitals, the generation of waste mostly occurs in every part. However, most hospitals have their own power and wastewater treatment plant. Different type of are likely to be produced by Health care units such as infectious waste, which must be collected, transported and treated well following the waste handling procedures to avoid the high risk of infection when it is not well handled.

Health care units' produces other waste category such as hazardous waste which is dangerous to living environment and people in general.

Another waste category is produced by health care units, the one which does not need to be separated from other waste. Each waste category has different treatment methods, separated in different bags and containers

According to the hospital colour coding, the waste categories in most of the Finnish hospitals are categorized into solid municipal waste, special medical waste and hazardous waste, these category have are divided into many sub-categorizes.
The waste category which contains infectious waste is disinfected when possible and the disinfected waste is then taken to the landfill. Other hazardous waste is incinerated in the hazardous waste treatment plants./12/

The waste issues in Finland are under the Ministry of Environment. The ministry formulates environmental policies, carries out strategic plans, and makes decisions in its own sphere of interest. It is also responsible for preparing legislation. There are also 13 Regional Environmental Centres which are supervising waste related issues and conditions of the environmental permits on their regions./9/

4.1.1 General information of Tampere University Hospital

TAUH is located in Tampere city, in southern Finland with approximately 209,749 populations. TAUH has approximately of 2700 workers and 760 hospital beds.
Tampere University Hospital is part of the Pirkanmaa Hospital District, which is a joint authority of 23 municipalities with 470,000 residents./20//6/

4.1.2 Services of Tampere University Hospital

TAUH provides health care services in the field of specialist within its area; it also promotes health and functional capacity, gives training about health care professionals and promotes scientific research into health./20/

TAUH operate in four localities and are organized into divisions in terms of its administration. TAUH is managed by the Administration Centre of the Pirkanmaa Hospital District./20/

TAUH responsibilities include;

I. Diagnosis and establishing the causes of diseases
II. Outpatient and other similar care
III. Inpatient care
IV. Consultation
V. Rehabilitation
VI. Training of health-care professionals
VII. Scientific research into health

4.1.3 Organization structure of Tampere University Hospital

The organizational structure of the TAUH is composed of administration services, medical services and division of maintenance.

1) Administration services deals with customer and information services, human resource services, training services, financing and accounting services, facility centre and occupational health.
2) Medical services deals with first Aid and observation, surgery and Anaesthesia, and Intensive care.
3) Division of maintenance deals with material service, food services, hospital maintenance, technical services and instrument maintenance.

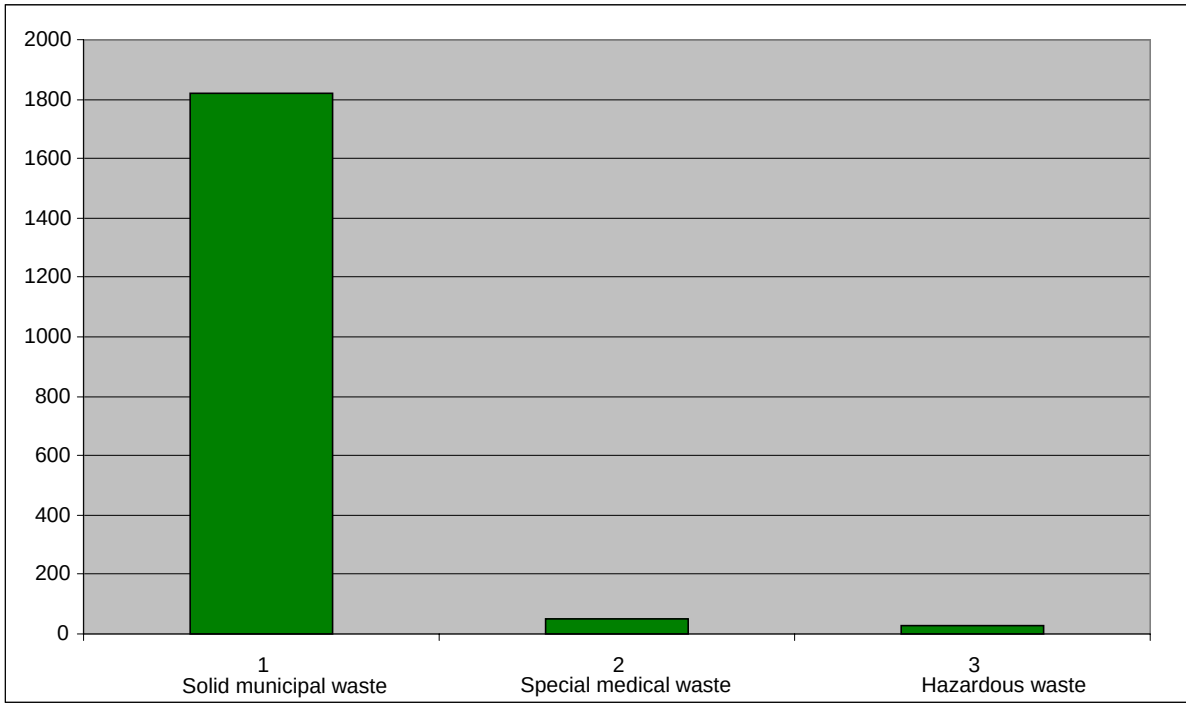
The department of internal medicine, respiratory medicine, Dermatology and Venereology is under administration services.

Department of neuroscience and rehabilitation, department of child Psychiatry, department of pediatrics is under both medical services and division of maintenance./21/

4. 2 Tampere University Hospital Waste

Tampere University Hospital waste instruction shows waste categorization, different type of waste, how they are collected, sorted, treated, packed and transported.
TAUH transports their waste to Ekokem hazardous waste treatment plant, which offers hazardous waste handling services./5/

Tampere University Hospital waste composition (in Tones) 2008



Graph 2. Waste composition of Tampere University Hospital per year

Solid municipal waste = 1821.63 tones per year

Special medical waste = 51.22 tones per year

Hazardous waste 26.967 tonnes per year

Tampere University hospital produces the total of 1899.817 tones of health-care waste per year. This waste production is of the year 2008

Waste utilization of Tampere university Hospital is 64.49%

Table 3. Explains the colour coding for the Pirkanmaa Hospital District

COLOR	**TYPE OF WASTE**
Black	Mixed waste
Transparent	Energy waste
Yellow	Infectious waste and the waste created using cytostatics
Red	Sharps, non-recognizable biological waste (marked with a tape)
Green	Glass (marked with a tape)

Table 4 below shows waste category of TAUH

Waste type	**characteristics**
Solid municipal waste	Solid municipal waste includes energy waste, recyclable cardboards, confidential papers, x-rays prints, magnetic tapes , glass, bio-waste, recyclable plastics, textile waste, construction waste , metal waste, saw dust.
Special medical waste	This includes sharps, recognizable biological waste, no-recognizable biological waste, Petri- dish from microbiological cultivation.

Hazardous waste	It includes medicine waste(Cyto-static waste, vaccination waste), radioactive waste (chemical waste, laboratory waste), mercury waste, fluorescent lamps, batteries waste and lead-containing waste

4.2.1 Waste Instruction Guidelines of Tampere University Hospital

Solid municipal waste is the waste that is generated from normal living in households, it is gathered and immediately separated after use, and it can be taken to the landfill or recycled again depending on the type of waste. For example energy waste is burned as energy production, recyclable cardboard boxes they are reused as raw materials, colour cassettes from the copy machines and printers are maintained and refilled by private enterprise./5//2/

4.2.1.1 Solid municipal waste

Depending on they type of waste,

- For energy waste material it is crushed and used for fuel in thermal power plants with other fuel, cans and foils are rinsed compressed to minimize surface area, they can be used as raw materials.

- Newspaper, white office paper, prints, envelopes, brochures, advertisements, telephone books. With this kind of separated paper there must not be dirty papers, plastics or plastic

covered papers, disposable containers, paper decorations, and stickers. This kind of waste need to be separated as energy waste or mixed waste.

- Construction waste generated from demolition work site, construction site, towing down insulation material or wood.

This kind of waste is packed into plastic bags for small size waste and the big ones is taken straight to transport platforms, for different kind of waste

- Papers/files that contain confidential information of the hospital or patients are kept in locked containers where no one can have access to.

- X-rays prints, audiotapes, magnetic tapes and personal data in sticker, they are separated into a locked marked vessel. Magnetic tapes and recording tapes can be cut with scissors.

- Bio-waste generated from the wards, hospital coffee rooms, hospital canteen is separated and they are taken to their collection point.

- Plastics covers, vessels are reusable after they are cleaned and can be used as energy waste but not PVC'S.

4.2.1.2 Special waste

Special medical waste this is the type of waste that is created in health-care procedures. It is composed of anatomical material, which is human or animal body parts, including tissues and organs; blood (human or animal), faeces of an diagnosed individual that have disease which can be transmitted, microbiological laboratory waste and sharps (syringe, needles and surgical instruments).
Special medial waste is taken by the hazardous waste treatment plant./10//2/

Treatment of special medical waste

- Undefined biological waste, that cannot be recognized, example parts of organs and tissues, laboratory test animal waste, operating waste, blood tubes and products that are bloody and excreted it. This type of waste is packed at the site where it is generated into water proof plastic bags or cardboard boxes marked with a tape which must be tight. It is collected and stored into a cooled place./5//2/

- Sharps are collected into plastics bottles or canisters, they are closed properly and they are not supposed to be compressed. Sharps are not supposed to be packed together with biological waste ./5//2/

- Recognizable biological waste (ethic waste), it is packed on the site where it is generated into water proof plastics bags, that are packed further into cardboard barred lined with plastic bag. Its is taken daily out of the wards, and then it is stored into a cooled place./5//2/

4.2.1.3 Hazardous waste

Hazardous waste this type of waste that contains hazardous properties that might render it harmful to human health or environment. Hazardous waste includes infectious waste, medicine waste, batteries, asbestos, mercury waste and unrecognizable or newly developed materials created by research and development activities.

Treatment of hazardous waste

Hazardous waste treatment depends on the type of waste. /5//2/

- Chemical waste is packed properly on the packages that fulfil the criteria, marked and stored in hazardous waste store or inflammatory store.

- Medicine waste is either returned to the hospital pharmacist or collected and separated on the wards according to the instructions. For single solid medicine products that are in closed packages are packed into vessels that are UN type approved. For liquid medicine like eye drops, vaccines and solutions, these are packed into packages that do not leak, plastic bags, vessels or canisters. Medicine waste should not be put into the sewer, and the liquid medicine should not be combined with each other.

- Amalgam waste is any waste that contains amalgam, technical devices that contains amalgam, also the sewer pipes. Amalgam waste must not be mixed with mercury waste, with the dentist instruments must be cleaned with the cloth before cleaning it for reuse. The amalgam waste and amalgam contaminated waste are packed into tight vessels and marked. The waste water that is generated from the dental care must be directed to the sewer where there must be amalgam separator. Amalgam collecting vessels are not allowed to be stored in the rooms where people are working.

- Batteries, chargers and lead (Pb) waste are collected into plastic jars or bags. Lithium chargers are collected separately.

If the charger cannot be separated out of the device, the whole device is separated in charger waste category.

The chargers and batteries have hazardous qualities and must be treated in hazardous waste treatment plant. Batteries and chargers must not be stored in work premises but they should be delivered to the collecting premises. Lead chargers are delivered to the hospital's hazardous waste storage. The transportation of this kind of waste must be documented.

- Radioactive waste is packed at the site where it is generated; there is a special nominated person in the hospital that is responsible for radioactive waste. Radioactive waste is packed into a tight plastic bag that can be transported in bigger bags that are marked with the producer identification, date and the names of the radionuclide. Radioactive

contaminated waste can be aged in a separate storage reserved only for radioactive.

- Cytostatic waste that are expired, spoiled, or contaminated are collected into the site where they are generated into tight plastic bags and after that into proper transportation vessels. The vessels are marked according to their content. The Cytostatic waste after collected it is cooled and locked into a storage room and wait for further transportation

- All kinds of fluorescent lamps and energy lamps are separated according to their qualities. They should be stored and packed so that they cannot break. They can be packed into their original packages for transportation.

4.2.2 Separation, collection and storage of waste

In the environment system of the hospital, the code of practice of waste management is defined. The goal of the system is to guarantee health and safety to the patients and the personnel as well as well as the environment. Quality control secures good level of hygiene./12/

Waste is separated at the sources according to their qualities. For biodegradable waste they are put in cold storages and packed tightly, to prevent them from smelling. Biological origin waste (contains blood or excretion) generated from operation theatres or from food waste, these kinds of packages needs special attention as the packages can break easily./5//7/

Waste is separated using colour codes. Regulated hazardous waste is never collected into the black, red and transparent packages but it has its own collection routes and special packages. All hazardous waste and special waste are marked at the source with the bar code of the waste producer like of the ward or responsibility unit. For the radioactive waste it is only stored in a radiation during ageing. Due to this, the exact ward and the properties of the waste is known during the whole life cycle of the waste.
The bar code is read and recorded before the waste leaves the hospital ground. To secure the standard the of the waste management, waste without a barcode is not accepted to transportation./12/

More than half household waste and part of the hazardous waste can be recyclable too. Recycled hazardous waste include solvents, X-rays films, developers and fixers, lead aprons, recoverable lead from radiation sources, batteries and fluorescent tubes.

It is not wises to arrange or require sorting for recycling if the whole reuse and recycling route is not secured and approved by the authorities./15/

5. Comparison of Muhimbili National and Tampere University Hospitals

The comparison of the waste management system between the two hospitals is based on their waste handling instructions, the amount of waste generated in hospital, classification, colour coding, transportation and final deposition.

Muhimbili University Hospital categorizes their waste into two main groups, Infectious and Non-infectious waste, as for Tampere University Hospital their waste division is under three category solid municipal wastes, special waste and hazardous waste, which is further divided into sub-categorizes.

Within the two division of Muhimbili National Hospital waste there are sharps which are separated into yellow safety box; hazardous waste is also collected into yellow bags marked, infectious waste is collected into red bags and Non-infectious waste is being collected into blue bags. Tampere University Hospital has different colour coding from Muhimbili National Hospital, instead of blue bags for Non-infectious waste; TAUH uses black bags for communal waste and transparent bags for energy waste. MNH uses red bags infectious waste but TAUH uses yellow bags. Reds bags in TAUH are being used for sharps and unrecognized biological waste.

Muhimbili National Hospital incinerates all their infectious waste inside the compound of the hospital. Infectious waste from Tampere University Hospital is being taken to waste treatment plant; they also have pre-treatment of the waste before the waste is being transported to the waste treatment plant, such example of this is radioactive waste, it is left to be aged in a separate storage reserved only for radioactive waste. Also cardboard packages, they are rinsed before they are flattened.

Tampere university hospital has a cold storage for biological waste, because such waste decomposes quickly and pollutes the air. This is not the case for Muhimbili National Hospital; the storage for biological waste is situated outside of the wards and has no cooling facilities.

MNH produces 1460tones of Non-infectious waste per year, 356 tones of Infectious per year and 24,000litres of chemical waste in a year.
Tampere University Hospital produces;

- Solid municipal waste = 1821.63 tones per year
- Special medical waste = 51.22 tones per year
- Hazardous waste 26.967 tones per year

Tampere University hospital produces the total of 1899.817 tones of health-care waste per year. This waste production is of the year 2008
The comparison of Non-infectious waste of MNH and solid municipal waste of TAUH shows that they produce more waste than MNH. This maybe due to;

- TAUH may have more medical services and departments than MNH /21//11/

- Number of patients maybe another reason. It might be TAUH receives more patient than MNH. This maybe due to Tampere is one of the Pirkanmaa regional district, this maybe be a reason to why TAUH receives more patient /20/

- Solid municipal waste in Tampere University Hospital is subdivided into many categories which gives its large quantity. Its is different from MNH as Non-infectious waste is being categorized into all the waste that has no characteristics of infection

- Another reason maybe due to most of the waste in MNH get intermixed, Non-infectious waste maybe sorted with infectious waste, and collected as infectious waste. This reduces the amount of Non-infectious waste collected

There is a large amount of infectious waste at Muhimbili National Hospital, 356 tones of infectious waste per year. This maybe due;

- MNH performs more surgical operations, and also MNH is one of the biggest public referral hospitals in Tanzania, it receives a lot of patients./11//19/
- Dar es salaam city is highly populated, this maybe be the reason why MNH has many patients
- High number of accidents leads to more production infectious waste

The waste from MNH is being transported by the contractors, which are subcontractors of Municipal council. The government authority approves the off-site transportation plan before any transit occurs. The transportation of the waste is properly documented and it is re-checked at the point of collection.
The MNH waste is then taken to the landfill which belongs to the Municipal council.

Tampere University Hospital transports their hazardous waste to Ekokem hazardous waste treatment plant and their radioactive waste is stored at STUK. Depending on the type of waste, some of the waste is being taken by the manufactures like machine part, and computers. Medicine waste which is no longer in use, it is taken back to the pharmacists, from the pharmacist the waste is taken to the hazardous waste treatment plant. Solid municipal waste, energy waste is taken by the contractors which are hired by the TAUH. /2//5/

6. Conclusion

Muhimbili National Hospital receives many patients because it's the main referral hospital in Tanzania, and also being situated in Dar es Salaam city. Health-care waste generated in Muhimbili National Hospital is in a large quantity is non-infectious waste (solid municipal waste). Non-infectious is generated in large quantity because the Hospital has staff quarters, university students and there is no treatment and utilisation of the non-infectious waste. Plastic waste, bio-waste, paper waste is all considered as non-infectious waste. Recycling of waste will be efficient at the hospital when the waste is separated at the point of generation. Infectious waste is incinerated at the hospital premises. Muhimbili National Hospital needs to take into consideration pre-treatment of infectious waste to reduce the amount of waste incinerated.

Auditing the health-care waste management is a good system for all hospitals. Internal audits and external audits in the hospital will alert the hospital management on the areas they need to focus for improvements. The hospital with a good quality environment should then be awarded with standard certificate which shows that their hospital environment quality in terms of waste handling is well maintained.

7. Discussion

MNH as well as TAUH has a good system of their waste separation according to their colour coding. This makes it easy at the point of collection and transportation. The both hospital has the system of marking the hazardous waste with liners or taped, this reduces the chance of mixing up the Health-care waste management procedures, techniques are to be considered and be planned before steps are taken. Reduction of the waste production can be done at the point of the generation; consideration of utilization, pre-treatment of waste is the main source of health-care waste reduction./12//16/

Raising awareness and training the hospital workers about risks associated with health-care waste will improve the waste management systems in the hospitals, using of safe methods and being careful in health-care waste separation.
There should be well documented instructions in every department for the health-care workers./16/

High temperatures for incineration of health-care waste as far as infectious waste is concerned should be mainly considered. When infectious waste is burnt at high temperatures, it produces low risk of pollution to the public. Location of the incinerator should be far away from the residential areas, as it produces low potential health risk to the public. The main disadvantages of burning infectious waste at low temperatures is the production of dioxins and furans, pollutants which affects the immune system and the functioning of the liver./16/

MNH waste management system has to improve their waste handling especially in sorting of the waste. In many waste collections point of the MNH, non-infectious waste and infectious waste are sometimes mixed up together, referring to figure 3 above. MNH should have more waste categorizes like TAUH so that more waste will be utilised. Non-infectious waste should be separated into mixed waste, energy waste, organic waste, and paper waste.

When non-infectious waste is separated into different categorizes it will be easier to utilize the waste into energy waste and bio-waste can be used for compost.
Pre-treatment of waste should be done inside the hospital premises before the final disposal.
Infectious waste should be treated before it is taken to the landfill as it reduces soil and water contamination./7/

The storage facilities at MNH for keeping the infectious waste should have freezing storage system. Infectious waste decomposes quickly and gives a bad smell, which irritates and contaminates the public. Dar es Salaam is a very hot city and this is the main reason that the MNH infectious waste decomposes quickly.
Most of the collection points at MNH are located near the wards therefore it will be ideal to keep the waste at the freezing point to prevent the decomposition.
MNH should research for other method of storing the infectious waste since the freezing storage facilities consumes a lot of energy.

MNH waste guidelines and policies are well written and indicated; they should be implemented by the hospital workers in order to produce the best quality of health-care waste system. All the workers should be trained before employed on how the health-care waste is handled.

All the workers should properly follow the hospital instruction guides and environmental legislation. The workers should also be well supplied with personal protective garments when handling health-care waste.

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